

CONNECTICUT RIVER FLOOD CONTROL

COLEBROOK RIVER DAM & RESERVOIR

WEST BRANCH, FARMINGTON RIVER
CONNECTICUT & MASSACHUSETTS

DESIGN MEMORANDUM NO. 1

SITE SELECTION



**U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.**

MARCH 1963

ENGW-EZ (13 Mar 63)

1st Ind

SUBJECT: Colebrook River Dam and Reservoir, Farmington River, Connecticut River Basin, Connecticut and Massachusetts, Design Memorandum No. 1, Site Selection

Office, Chief of Engineers, Washington 25, D. C., 11 April 1963

TO: Division Engineer, U. S. Army Engineer Division, New England

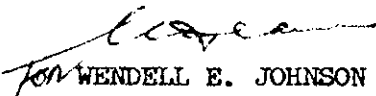
Design Memorandum No. 1, Site Selection is approved subject to the following comments:

a. Table III, Page 26, Item Stream Control. The estimated cost of \$100,000 should be reviewed for sufficiency as the cofferdams are located in an existing pool.

b. If the hydroelectric potential of the proposed project is uneconomic by a wide margin, no provisions for future power installation will be made. However, in the event that power has economic promise, initial provisions for future power should be kept to a minimum.

FOR THE CHIEF OF ENGINEERS:

Incl w/d


WENDELL E. JOHNSON
Chief, Engineering Division
Civil Works

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS

424 TRAPELO ROAD
WALTHAM 54, MASS.

DRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.

13 March 1963

NEDGW

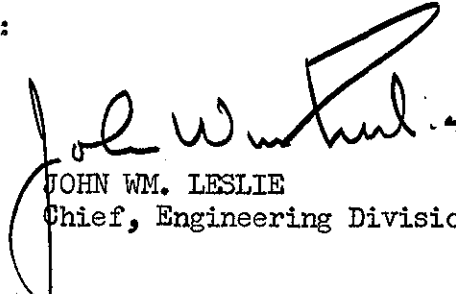
SUBJECT: Colebrook River Dam and Reservoir, Farmington River,
Connecticut River Basin, Connecticut and Massachusetts,
Design Memorandum No. 1, Site Selection

TO: Chief of Engineers
ATTN: ENGCW-E
Department of the Army
Washington, D. C.

There is submitted herewith for review and approval
Design Memorandum No. 1 - Site Selection for the Colebrook River
Dam and Reservoir, Farmington River, Connecticut River Basin, in
accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

Incl (10 cys)
Design Memo No. 1
Site Selection



JOHN WM. LESLIE
Chief, Engineering Division

FLOOD CONTROL PROJECT
COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT AND MASSACHUSETTS

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COLEBROOK RIVER DAM AND RESERVOIR

WEST BRANCH FARMINGTON RIVER

CONNECTICUT RIVER BASIN

CONNECTICUT AND MASSACHUSETTS

DESIGN MEMORANDUM NO. 1

SITE SELECTION

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COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
CONNECTICUT RIVER BASIN
CONNECTICUT

A. PERTINENT DATA
(PRELIMINARY)

	<u>Report Site</u>	<u>Both Sites</u>	<u>Upstream Site</u>
1. <u>Purpose.</u>	Flood Control and Water Supply		
2. <u>Location of Dam.</u>			
State	Connecticut		
County	Litchfield		
Town	Colebrook		
River	West Branch Farmington River		
Miles upstream from confluence with Still River	3.3		3.9
3. <u>Drainage Areas.</u>		<u>Square Miles</u>	
West Branch Farmington River, Gaging Station near New Boston, Massachusetts		92	
West Branch Farmington River at Damsite	119		118
West Branch Farmington River at Hogback Dam		120	
West Branch Farmington River at Gaging Station above Still River at Riverton		130	
Farmington River at mouth, confluence with Connecticut River		602	
4. <u>Stream Flow.</u>			
Record of U.S.G.S. Gaging Station on West Branch Farmington River near New Boston, Massachusetts, June 1913-September 1961.			

4. Stream Flow (cont'd)

<u>Time</u>	<u>c.f.s.</u>
Average annual	184
Maximum year (1928)	341
Minimum year (1957)	93.1
Maximum month (August 1955)	1,002
Minimum month (August 1957)	5.68
Maximum day (August 19, 1955)	16,100

5. Maximum Floods of Record.

Record of U.S.G.S. Gaging Station on West Branch Farmington River near New Boston, Massachusetts.

<u>Time</u>	<u>c.f.s.</u>
19 August 1955	34,300
21 September 1938	18,500
31 December 1948	11,700
18 March 1936	9,080
16 October 1955	7,910
3 November 1927	6,610

6. Criteria for Spillway Design Flood.

Peak inflow to reservoir, c.f.s.	166,000
Total volume of rainfall, inches	23.7
Infiltration rate, inches per hour	0.07
Total volume of runoff, acre-feet	135,000
Total volume of runoff, inches	21.2
Duration of flood, hours	27

	<u>Report</u>	<u>Upstream</u>
Reservoir stage at start of flood, ft., m.s.l. (spillway crest)	749	756
Outlet works	in operation and discharging 7,000 c.f.s.	

7. Reservoir.

Towns and counties affected:

Colebrook, Litchfield County, Connecticut, Sandisfield, Berkshire County, Massachusetts and Tolland, Hampden County, Massachusetts.

7. Reservoir (cont'd)

Elevations, Areas and Capacities

Report Site

<u>Pool</u>	<u>Elevation</u> <u>ft. m.s.l.</u>	<u>Area</u> <u>Acres</u>	<u>Acre</u> <u>Feet</u> <u>(net)</u>	<u>Inches on</u> <u>Drainage Area</u> <u>(approx.)</u>
Water Supply				
Existing	641	415	13,000	2.0
Immediate Use	655	500	6,500	1.0
Future Use	695	750	24,200	3.8
Flood Control	749	1,140	50,800	8.0
Total			94,500	14.8

Upstream Site

Water Supply				
Existing	641	355	10,800	1.7
Immediate Use	659	455	6,500	1.0
Future Use	700	705	24,200	3.8
Flood Control	756	1,125	50,800	8.1
Total			92,300	14.6

8. Dam.

	<u>Report</u>	<u>Both</u>	<u>Upstream</u>
Type	Rolled fill, earth		
Top width, feet		25	
Maximum base, width, feet	1,235		1,235
Maximum height, feet	213		213
Total Length, feet	1,165		1,270
Upstream Slope		1 on 3	
Downstream Slope		1 on 2½ to elevation 641 then 1 on 3 to old stream bed	
Freeboard above spillway design flood height, feet		5.0	

8. Dam (cont'd)

	<u>Report</u>	<u>Both</u>	<u>Upstream</u>
<u>Elevations</u> (feet above mean sea level)			
Top of dam	773.0		780.0
Base of dam (stream bed at centerline)	560.0		567.0
Maximum surcharge (Spillway Design Flood)	768.0		775.0
Top water supply pool	695.0		700.0
Top flood control pool, spillway crest	749.0		756.0

9. Dike.

Type	Rolled fill, earth		
Top width, feet	25		
Maximum base width, feet	275		305
Maximum height, feet	47		54
Total length, feet	430		480
Upstream Slope		1 on 3	
Downstream Slope		1 on 2½	

10. Spillway.

Type	Uncontrolled side channel, concrete overflow, L shaped		
Crest length, feet	355		
Elevation of crest, feet m.s.l.	749		756
Maximum head, feet (above spillway crest)		19	
Maximum inflow from spillway design flood, c.f.s.		166,000	
Spillway peak discharge, c.f.s.		111,800	

11. Outlet Works.

Type	Concrete conduit		
Size of conduit	10 feet diameter		
Intake tower	Concrete		
Gates	3		

12. Real Estate.

	<u>Report</u>	<u>Upstream</u>
Total to be acquired, acres	1,832	1,791
Classification, Acres		
Metropolitan District	1,645	1,570
State Forest	11	12
Private		
Home Sites	8	8 $\frac{1}{2}$
Open Land	45	57 $\frac{1}{2}$
Wooded, Waste & River	120	137
Gravel Pit	-	3
Cemetery	3	3
Total	1,832	1,791
Improvements		
Residences with outbuildings	4	4
Machine Shed	0	1

13. Relocations.

	<u>Report</u>	<u>Upstream</u>
a. Roads		
Highways, Existing Mileage	4.9	5.3
Highways, Proposed Mileage	4.9	5.3
b. Utilities		
Power and telephone removal	1.2	1.2
c. Cemetery		
No. of Graves	70	70

14. Principal Quantities.

	<u>Report</u>	<u>Upstream</u>
Common Excavation	64,100 cy	59,100 cy
Talus Removal (Max.)	406,000 cy	-
Rock Removal (Max.)	133,000 cy	-
Borrow Excavation	3,270,000 cy	3,130,000 cy
Rock Excavation	291,000 cy	337,000 cy

14. Principal Quantities (cont'd)

	<u>Report</u>	<u>Upstream</u>
Embankment		
Rolled Embankment	2,720,000 cy	2,610,000 cy
Rock Fill	280,000 cy	335,000 cy
Rock Slope Protection	83,800 cy	86,800 cy
Concrete	22,600 cy	22,600 cy
Cement	33,900 bbl	33,900 bbl

15. Estimated Project Cost.

	<u>Report</u>	<u>Upstream</u>
Lands and Damages	\$ 189,000	\$ 207,000
Relocations	2,807,000	3,036,000
Reservoir	120,000	134,000
Dam & Appurtenant Structures	7,548,000	6,197,000
Road and Bridge	271,000	141,000
Buildings, Grounds & Utilities	86,000	86,000
Permanent Operating Equipment	19,000	19,000
Preauthorization Studies	20,000	20,000
Engineering and Design	880,000	800,000
Supervision and Administration	<u>760,000</u>	<u>660,000</u>
TOTAL	\$12,700,000	\$11,300,000

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424 TRAPELO ROAD
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FLOOD CONTROL PROJECT

COLEBROOK RIVER DAM AND RESERVOIR
WEST BRANCH FARMINGTON RIVER
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DESIGN MEMORANDUM NO. 1

SITE SELECTION

13 March 1963

B. INTRODUCTION

1. Purpose. - The purpose of this memorandum is to furnish information relative to studies made in the selection of a site for the Colebrook River Dam. Site selection recommended herein is based on the most economical location which will maximize net benefits. Two sites have been studied, the Report Site shown in the authorizing document and an Alternate Site, located approximately 3,100 feet upstream of the site recommended in House Document No. 443, Eighty-sixth Congress.

2. Scope. - This memorandum presents general data for the project insofar as it may affect the selection of site. No attempt is made to include comprehensive coverage of all the subjects included in the various sections of this memorandum.

C. AUTHORIZATION

3. Authorization. - The Colebrook River Project was authorized by the Flood Control Act approved July 14, 1960, Public Law 86-645 which reads in part as follows:

"The plan for flood control and related purposes on the Farmington River, Connecticut and Massachusetts, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document No. 443, Eighty-sixth Congress, Second Session, at an estimated cost of \$12,052,000."

4. In House Document No. 443, the Chief of Engineers recommended the construction of a dam and reservoir at the Colebrook River site for flood control and water supply purposes at an estimated construction cost of \$11,280,000 (exclusive of preauthorization studies) provided local interests agree, prior to construction, to repay the United States all allocated costs of water supply storage, presently estimated at \$4,300,000.

D. INVESTIGATIONS

5. Previous Investigations. - An interim report on Review of Survey, Farmington River Basin was submitted in December 1958 and published without appendices in House Document No. 443, 86th Congress, 2nd Session. The preparation of the report was authorized by resolution of the Committee on Public Works of the United States Senate on 14 September 1955. The report provided for the construction of a flood control and water supply reservoir of 81,500 acre-feet capacity. The flood control capacity, of 50,800 acre-feet, is equal to 8 inches of runoff. The 30,700 acre-feet of water supply capacity is equal to 10 billion gallons. The site was located on the West Branch Farmington River about 3.3 miles above its confluence with the Still River with spillway at Elevation 747.0 m.s.l.

6. Current Investigations. - Studies for the project plan utilized the basic data obtained for the previous investigations. Hydrologic studies were made to review the recommended reservoir capacity and to determine the spillway design flood. Consideration was given to additional storage for water supply purposes and for low flow augmentation for the downstream fishery and water quality control. Aerial photogrammetry was obtained and a preliminary survey for a possible chute spillway and a base line profile at the upstream site were made. Detailed surveys of the report site were made and potential sources of borrow material investigated. Reconnaissance was made of both sites and two borings and a test pit were made on the west abutment at the upstream site. Appraisals of lands and damages in the reservoir and work areas have been made.

E. LOCAL COOPERATION

7. Local Cooperation. - No local cooperation is required for the flood control portion of the project. The Metropolitan District of Hartford has continued its interest in the project and has furnished assurances of its local cooperation in the water supply portion of the project. Legislation has been requested to enable the Metropolitan District to enter into an agreement with the United States and to use the waters stored in the reservoir. In the November 1962 election, the voters of the District approved the appropriation of \$6,000,000 for the District's share of the cost.

F. LOCATION OF PROJECT AND TRIBUTARY AREA

8. Location of Dam and Reservoir. - The Colebrook River Dam site is located in northwestern Connecticut, in the Town of Colebrook. It is on the West Branch Farmington River about halfway between the Village of Riverton and the former Village of Colebrook River. Colebrook River Village site was vacated because of being within the pool of the Hogback Water Supply Dam, owned by the Metropolitan District of Hartford, and the project site also lies within this pool. The reservoir of the Colebrook River Dam will extend into the southwestern part of Massachusetts.

9. Description of the Farmington River Basin. - The Farmington River Basin, the fourth largest sub-basin of the Connecticut River system, is located in southwestern Massachusetts and north-central Connecticut, within the confines of Berkshire and Hampden Counties in Massachusetts, and Litchfield and Hartford Counties in Connecticut. The Farmington Watershed has a maximum length of 46 miles, a maximum width of 29 miles, and a total drainage area of 602 square miles. The West Branch is one of its major tributaries.

10. West Branch Farmington River. - The West Branch Farmington River rises in Shaw Pond on the Otis-Becket, Massachusetts, town line and flows in a general southerly direction for about 33 miles to its confluence with the East Branch, in New Hartford, Connecticut, below the dam site. The portion of the basin above Riverton is bounded on the southwest by the Still River and Sandy Brook watershed, and on the east by the East Branch watershed, all within the Farmington River Basin. It is bounded on the west by portions of the Housatonic River watershed and on the northeast by portions of the Westfield River watershed, which is also tributary to the Connecticut River. The West Branch Basin above Riverton is irregular in shape, with a maximum length in a general north-south direction of about 22 miles and a maximum width in an east-west direction of about 9 miles. The river falls about 780 feet from its source at Shaw Pond to the project site in a distance of about 19 miles. The watershed is quite hilly, with scattered swamps and ponds in some of the valleys. The area is rural and sparsely settled, with the hills and most of the valleys covered by dense woods.

G. ALTERNATE SITES

11. Report Site. - The site recommended in House Document No. 443, hereinafter referred to as the report site, is located at a narrowing of the valley walls of the West Branch Farmington River in the Town of Colebrook, Connecticut, about 3.3 miles upstream of the confluence of the Still River and the West Branch. The site is located about 4,500 feet upstream of the Hogback Dam of the Metropolitan District and within its water supply reservoir. The Colebrook River pool would extend along the West Branch for 6.3 miles above the dam and into the Towns of Sandisfield and Tolland, Massachusetts.

12. Upstream Site. - The alternate site recommended herein is located about 3,100 feet upstream of the report site. In many respects the two sites are similar, both being located in the Hogback pool at a narrowing of the valley walls. The upstream site is also in the Town of Colebrook and is about 3.9 miles upstream of the confluence of the West Branch Farmington River and the Still River. At the upstream site, the reservoir would extend along the West Branch for about 5.9 miles and into the Towns of Sandisfield and Tolland, Massachusetts. The reservoirs overlap to a considerable extent. The report site, the upstream site and the reservoir areas are shown on Plates 1-1A and 1-1B. General plans for the two sites are shown on Plates 1-2 and 1-3.

H. HYDROLOGY

13. General. - The drainage area of the alternate upstream damsite is 118 square miles compared with 119 square miles at the report site. As the decrease in watershed is less than one percent, there is no significant change in the hydrologic analysis of the two sites, nor is there any appreciable effect on the downstream flood control effectiveness. Area and capacity curves are shown on Plates 1-4 and 1-5.

14. Spillway Design Flood. - The computed spillway design flood for the report site will be used also for the upstream alternate site. The inflow flood has been routed through the surcharge storage curve for the upstream site to obtain applicable surcharge-length relationship for the spillway. Present studies show that the spillway dimensions for both sites are essentially the same.

15. Reservoir Capacity. - The Colebrook River Dam was authorized to provide 50,800 acre-feet or 8 inches of flood control storage from the 119 square miles of drainage area. Water supply storage in the amount of 10 billion gallons or 30,700 acre-feet also was authorized. This water supply storage would be in addition to storage presently available in the Hogback Reservoir. Hogback Reservoir, with the crest at elevation 641 feet, m.s.l., will back water into either site. The following tabulation gives the approximate elevations that would be adopted for each of the two sites under consideration.

	<u>REPORT SITE</u>	<u>UPSTREAM SITE</u>
	D.A. = 119 sq. mi.	D.A. = 118 sq. mi.
Hogback Reservoir		
Spillway Crest Elevation	641 ft. m.s.l.	641 ft. m.s.l.
Storage within Colebrook	13,000 ac. ft.	10,800 ac. ft.
Colebrook Water Supply		
Top of Water Supply Pool	695	700
Storage	30,700 ac. ft.	30,700 ac. ft.
Colebrook Flood Control		
Spillway Crest	749 ft. m.s.l.	756 ft. m.s.l.
Storage	50,800 ac. ft.	50,800 ac. ft.

More precise values will be determined on the basis of the volume of embankment and borrow excavation within the reservoir.

I. GEOLOGY

16. Regional Geology and Topography. - The West Branch of the Farmington River flows through the Western Highlands of Connecticut, a rugged maturely dissected upland of moderate relief underlain by crystalline rocks. It is a region of rough, irregular hills and relatively deep, steep-sided valleys. Glaciation has modified the rough topography by rounding and smoothing the crests of the hills and ridges, steepening some of the valley walls, and filling the valley bottoms. A thin veneer of till covers the hills and ridges between extensive areas of exposed bedrock. Locally till occurs also in the valleys but generally the valleys are filled with out-wash materials which form relatively wide, flat flood plains and extensive terraces along the lower valley slopes. Where not

masked by the terraces, numerous and persistent outcrops of bedrock occur along the flanks of the hills, and in the valleys the streams have uncovered bedrock in many areas. The bedrock of the region consists of Paleozoic schists, gneisses and granites.

17. Report Site Explorations. - Subsurface explorations consisting of 5 test borings were made in 1957 for an interim report on Review of Survey. The location of these explorations and the distribution of bedrock exposures are shown on Plate 1-2. Current investigations for this site have consisted of a detailed topographic survey and geologic examinations leading to a tentative exploratory layout for final design studies.

18. Upstream Site Explorations. - Consideration was given to this site in May of 1962 for the principal reason that aerial photos and reconnaissance showed possibility for a chute spillway in a conspicuous gully high on the shoulder of the spur forming the left abutment. The Report Site would reasonably accommodate only a side channel type of spillway involving hazards and difficulty of construction and maintenance of deep excavation up to 200 feet. From examination of the Upstream Site coupled with partial topographic survey it developed that a chute spillway was feasible, access less difficult and that the detrital rock and boulder condition hereinafter referred to as talus apparent at the Report Site was not present, at least on the left abutment where bedrock frequently outcrops and intervening overburden is thin. Subsequent preliminary cost comparison without benefit of full topographic survey at the Upstream Site revealed a difference greatly in favor of the Report Site. As a result of these studies detailed topographic surveys were made and design explorations planned for the Report Site. Later more refined estimates based on additional topographic survey at the Upstream Site and with increased consideration to the talus removal at the Report Site brought the comparative costs of the sites into proximity deserving this memorandum. In the course of these studies, two test borings and a test trench were made in January of this year on the right abutment of the Upstream Site where the rock surface is concealed. The fluctuating pool and ice conditions in the Hogback Reservoir did not permit explorations in the valley bottom for a better comparison in this section with the Report Site. The locations of explorations and distribution of bedrock exposures is shown on Plate 1-3.

19. Site Geology - Report Site. - The site is located at the maximum construction of the valley in this stretch of river. The valley profile depicting subsurface conditions as shown on Plate 1-6 is on the Survey Base-Line or approximate proposed center-line for

embankment. Bedrock (granitic gneiss) outcrops at about Elevation 595 a short distance upstream of the profile on the left or east abutment and extends upward in several parallel ribs to about Elevation 630. The dip of foliation is near vertical and the orientation N 60° E striking across the river. Above about Elevation 775, or height of dam on the proposed center-line, bare rock faces range in slope from 60° to vertical and in part overhanging. These faces, though beyond the limits of embankment, present a potential hazard of fall-out of joint blocks during construction. Site preparation includes a preliminary estimate for hazardous rock removal.

The talus consisting of boulders and large blocks on the left abutment is indicated in profile and generally covers the abutment area and presents a particularly rough surface condition downstream of the survey base-line. A similar talus condition occurs on the right or west abutment (Figure 1) above a pervious terrace remnant at about Elevation 640 as shown in profile. Site preparation provides for complete removal of talus to the rock surface within the embankment area. Field observations estimate the talus to range from 10 to 20 feet or more locally in thickness. The actual depth, and condition of the talus is not revealed by the initial borings which border on or are located outside the talus areas. Extensive test excavations would be necessary to more fully determine the depth range and character of the talus. However, more than ordinary excavation of a difficult rock nature would be involved if the condition proved to be only a near surface condition.

The overburden of the stream section is pervious glacial outwash and a remnant terrace of these materials forms the lower and middle right abutment to about Elevation 640. The presence of a deeper buried channel than assumed in profile is possible but the position of the rock surface as exposed and initially explored in this construction of the valley would restrict it to a narrow v-shaped channel.

20. Site Geology - Upstream Site. - This site is similar in surface profile to the Report Site with a somewhat wider stream section as compared on Plate 1-6. A steep terrace remnant similar to the Report Site forms the surface of the lower and middle right abutment. The right abutment above the terrace remnant is a boulder strewn surface of glacial till thinly covering the rock surface. The stream section without benefit of exploration is assumed to have overburden conditions similar to the Report Site, but with possible greater width of buried channel.

The left or eastern abutment is bedrock controlled with thin overburden between long, low rib outcrops which trend generally up the abutment. The rock is generally a quartz-biotite schist which trends North 50-60° East and dips vertically in structure similar to the Report Site. The schist is intruded by granitic stringers and large lenses so that in extensive areas it is granitized to a gneiss similar to the rock at the Report Site. A rock trough occurs on the left abutment just downstream of the profile presented on Plate 1-6. The trough trends and widens down the abutment aligned with the strike of the rock becoming about 100 feet wide and 30 feet deep before it disappears beneath the existing reservoir pool. The floor of the trough is paved with rock blocks (Figure 2) and constitutes the only area of the embankment foundation having a talus condition similar to the Report Site.

21. Structure Excavations - Rock. - Similar rock types, gneiss, schist, granite and occasional pegmatite bodies will be encountered at both sites with the foliated or banded schists and gneisses predominating. The near vertical foliation and trend of these rocks across the proposed alignments for spillway and outlet works excavations at both sites is favorable to overbreak control and slope stability but strongly developed joints normal to the trend of foliation may nullify this advantage to some degree by fallout and necessary removal. No unusual foundation conditions are indicated at this stage of investigations for either site.

J. SITE PREPARATION

22. Site Preparation. - The extent and cost of site preparation differ appreciably for the report and upstream sites in favor of the upstream site. As described in paragraph 19, the abutments of the Report Site are covered with talus, and loose rock and blocks. The talus within the confines of the embankment must be removed to insure foundation stability. In addition, it will be necessary to remove loose rock and rock blocks on the abutments, particularly the left abutment, above the embankment both for safety during construction and to eliminate potential hazard to the conduit intake and tower. Except for a relatively minor amount of talus to be removed from the gully on the left abutment of the Upstream Site, these problems are not present upstream.

K. EMBANKMENT DESIGN

23. General. - The dam embankment at either the Report Site or the Upstream Site will consist of a compacted earth fill section with rock slope protection and a small rockfill section. Although not indicated on the general plans (Plates 1-2 and 1-3), the dam will be arched about 75 feet upstream at either site. Tentative embankment slopes are 1 on 3 upstream and 1 on $2\frac{1}{2}$ downstream, except below El. 641, where the slope would be flattened to 1 on 3 below the spillway crest elevation of Hogback Dam. The zonation of the earthfill section as well as the outer slopes will be established in later stages of design following more detailed materials studies. It is evident, however, that the greater portion of the earthfill section will be constructed of material obtained from gravel deposits along the river north of the Upstream Site at a haul distance of from 5,000 to 8,000 feet from the Report Site or from 2,000 to 5,000 feet from the Upstream Site. The earthfill section will also include a relatively small zone of impervious fill (probably a central core) constructed of materials obtained from glacial till deposits west of the river. It is considered that sources of impervious materials can be developed for either site, but with somewhat greater haul distances at the Report Site. Foundation seepage at either site will be controlled by a foundation cut-off extended to bedrock and a grout curtain in the bedrock. Information presently available indicates that cut-off depths would be the same at either site and that grouting costs would also be about the same at either site. Although the above ground features of the dam embankment at either site will be essentially identical, the problems involved in the preparation and treatment of the embankment foundations are quite different as discussed in the following paragraphs.

24. Report Site. - The principal features of the embankment foundation area for the Report Site affecting embankment design and construction are the talus deposits on portions of both abutments. The large size of much of the talus material and the steepness and indicated open character of the deposits make it impossible as a practical matter to consider the construction of an earthfill dam upon these deposits. Foundation preparation at this site, therefore, involve the complete removal of talus within the embankment foundation area. Since these talus deposits are on steep slopes it will be necessary for reasons of safety to require removal of talus above and outside the embankment area and consequently there may be as much talus excavation outside as there is inside the embankment foundation area.

25. Upstream Site. - In contrast to the foundation area at the Report Site, that at the Upstream Site contains no visible talus deposits except in the gully on the left abutment. Therefore, foundation preparation and treatment will be less costly. Also, the quantity of talus and loose or unstable rock to be removed beyond the limits of the embankment will be substantially less if not negligible.

L. DIKE

26. Dike. - An earth dike is required to close the west rim of the reservoir adjacent to the Sandy Brook Watershed. No problems are anticipated in its design. Use of the Upstream Site will result in a 7-foot increase in height.

M. SPILLWAY AND OUTLET WORKS

27. Spillway. - The L-shaped side channel spillway with 19-foot surcharge has been determined to be the most economical for the Report Site and can be used for the Upstream Site. Concrete quantities will be essentially the same for either site. Consideration will be given to the possibility that steeper embankment slopes can be used with the larger quantities of rock available from a chute spillway. This may result in overall economy in the project.

28. Outlet Works. - As the height of dam is the same for both sites, the outlet works would be identical or nearly so. Except for small variations in earth and rock excavation, the cost for either site will be the same.

N. ACCESS ROADS

29. Highways. - The project area is accessible via a network of highways, principally Route 8 which extends in a north-south direction through Massachusetts and Connecticut Route 20 which passes through Riverton in a northeast-southeast direction. The Hogback Dam can be reached via secondary roads, easterly from Route 8 or northerly from Route 20 near Riverton.

30. Access Roads. - Access to the Report Site may be gained across steep, wooded, rocky and difficult terrain from the vicinity of the Easterly end of Hogback Dam. An access road from near the westerly end of Hogback Dam would require crossing the spillway channel and would be in equally difficult terrain as it approached

the dam. The most feasible access to the Report Site may very likely be along the edge of the Hogback pool where the terrain is relatively less difficult, across the downstream end of the spillway channel and ramping up the downstream slope of the dam on a 10 percent grade.

Access to the Upstream Site may be gained from Route 8 crossing the top of dike and then along the edge of the reservoir. This access route is considerably shorter than the access routes to the Report Site, it does not require a bridge and the terrain, although steep, is not as rugged.

O. SOURCES OF CONSTRUCTION MATERIALS

31. General. - Investigations in progress for sources of natural earthen borrow materials are in areas contiguous to both sites but with some haul advantages to the Upstream Site.

32. Impervious Material. - Initial subsurface explorations are in progress for development of an impervious borrow area in glacial till. The area is adjacent to State Highway Route #8 on the lower west slope of Eno Hill which on its eastern slopes forms the right abutments at the dam sites. The position of this area provides a relatively short direct haul to the Upstream Site. An area not yet explored on the south side of Eno Hill presents a potential for similar direct haul to the Report Site.

33. Pervious and Select Pervious Materials. - The borrow requirements for these materials amount to about two million cubic yards and are available from the extensive terrace deposits of glacial sands and gravels along the river within the reservoir, particularly in the widening of the valley upstream of the Upstream Site. These deposits have been recently explored by 18 large bulldozed trenches dissecting the terraces from their land ties to the present limiting edge of the Hogback pool. It is conservatively estimated that three million cubic yards of materials for use in random and pervious fills are available from the terraces including their presently unexplored portions beneath the existing pool. The bulk of these materials is handily available from terraces starting immediately upstream of the Upstream Site and a lesser explored quantity available immediately downstream of the Report Site.

34. Rock Fill and Slope Protection. - The character of the rock from required excavations at the Report Site from examination of exposures and of cores taken to date is gneissic in character bordering on granite in some areas. The rock at the Upstream Site is generally schistose but in extensive areas is granitized to a gneiss and some outcrops on the left abutment are pegmatite, a very coarse granite. It appears at this stage of investigations that a more solid, blocky fragmentation will be obtained from the Report Site, but that rock from the Upstream Site will have better than average suitability for use in fill and for slope protection, and that pegmatitic zones susceptible to easy breakdown may be encountered in excavations at both sites.

35. Concrete Aggregates. - The availability of concrete aggregates is not a factor in site selection. The quantity of concrete required for either site is relatively small and processing of aggregates on site is not considered economical. A number of commercial sources are available within 30-miles haul distance, three of which have been previously tested and approved for other civil works projects. All potential sources will be investigated and a detailed discussion of the aggregate investigations will be included in Design Memorandum No. 8, "Concrete Materials".

P. WATER SUPPLY STORAGE

36. Water Supply. - The Colebrook River water supply storage will be used to augment the present sources of the Metropolitan District. The project site is situated so close to the Hogback Dam that the reduction in drainage area will not affect the yield of the combined projects.

Q. HYDROELECTRIC POWER

37. Hydroelectric Power. - The future development of hydroelectric power could be accomplished equally as well at either site. From discussions with representatives of the Federal Power Commission it appears that provisions for future power installation can be made without major modifications in the project as designed for flood control and water supply. In the development of the project, consideration will be given to inclusion of a steel conduit liner to serve as a power penstock.

R. RESERVOIR MANAGEMENT AND PUBLIC USE

38. Recreation. - Substantially all lands required for the project in Connecticut and a considerable portion of the Massachusetts lands were acquired by the Metropolitan District for construction and protection of its water supply. Under Connecticut law these lands in Connecticut are open for public hunting, fishing and boating. Swimming is prohibited. It is expected that this usage will be maintained in Connecticut and extended to all project lands in Massachusetts.

Recreational uses of the water area will be severely limited by the extreme drawdown of the water supply pool. Based on a minimum pool level of 585 m.s.l. at Hogback this drawdown would be 110 feet for the Report Site and 115 feet for the Upstream Site. Much of this drawdown will occur in the summer months.

Tentative operating plans for the water supply storage provide for maintaining the Hogback pool relatively constant until the Colebrook water supply storage is depleted. This pool may have definite recreational value. The use of the Upstream Site will increase the area of this pool by about 50 percent and should enhance the recreational potential of the area.

S. REAL ESTATE

39. General. - The acquisition of land for the Colebrook River Dam and Reservoir will be made in accordance with the project authorization and current policies expressed in EM 405-2-150. Special consideration will be given to considerations peculiar to the site. Approximately 90% of the land required for the project is owned by the Metropolitan District of Hartford. The District acquired these lands for the purposes of water supply storage and watershed protection. Hunting, fishing and boating are allowed under Connecticut State Law.

40. Area Description. - The Colebrook River Dam and Reservoir project, located in the Farmington River Basin, is in the Town of Colebrook in the State of Connecticut and the Towns of Sandisfield and Tolland in the Commonwealth of Massachusetts. The project area is mainly cleared reservoir land and wooded land. There are four substantial residential properties near the upper limits of the reservoir which will be acquired.

41. Title to be Acquired. - It is proposed to acquire an easement on the Metropolitan District lands for construction, maintenance and operation of the dam and for flowage. The easement will include the right for public access for hunting, fishing and boating on project lands within the Commonwealth of Massachusetts. Under Connecticut law the project lands in Connecticut are open for these purposes and thus no further interest is considered necessary. Acquisition of a flowage easement on a small portion of State Forest lands in the State of Connecticut is also proposed. Privately owned lands below the static full pool elevation and within 300 feet outside this limit together with lands to allow for induced surcharge operation will be acquired in fee.

42. Water Rights. - The only water right noted is that of the Metropolitan District which owns the Hogback Reservoir. Since the Colebrook River storage will be above the present Hogback storage there will be no permanent effect upon the existing water rights. The damages created by unwatering the Hogback Reservoir during construction have been included in the estimate of the cost of constructing the dam.

43. Relocations. - Lands required for the relocation of Route 8 within the State of Connecticut are owned by the Metropolitan District of Hartford. Therefore they are estimated at nominal value. Since the road will be relocated within the 300-foot horizontal area at the upper end of the reservoir no additional privately owned lands are required.

44. Estimate of Cost. - The estimated real estate costs for the two sites are shown in Tables I and II which follow:

TABLE I
REAL ESTATE FOR REPORT SITE

10' Surcharge + 300 ft. Horizontal	1682 acres	
MDC & State Forest	1514 acres	
MDC Boat Landing Area	2 acres	
Private Lands	166 acres	
Improvements - Total Estimated Value		\$ 86,000
Land (Easement)		
MDC & State Forest Lands	1514 acres	\$ 5,000
MDC Boat Landing Area	2 acres @ \$2000=	4,000
Land (Fee)		
Private Lands - Total Acres	166 acres	
Home Sites	8 acres @ \$1500=	12,000
Open Land	45 acres @ \$ 400=	18,000
Wooded, Waste & River	110 acres @ \$ 50=	5,500
Cemetery	3 acres **	<u> </u>
Borrow Areas		
MDC Land (Easement)	140 acres	*
Private Land (Fee)	10 acres @ \$300	3,000
Land Total Estimated Value		\$ 47,500
Severance		13,000
Cemetery Relocation	3 acres @ \$2000	6,000
Contingencies		14,800
Acquisition Costs	16 tracts @ \$1200	19,200
Resettlement Costs		2,500
TOTAL ESTIMATED VALUE		\$189,000

* Value included in \$5000 item for M.D.C. & State Forest Lands.
 ** Value included in relocations.

TABLE II
REAL ESTATE FOR UPSTREAM SITE

10' Surcharge + 300 ft. Horizontal	1641 acres
MDC & State Forest	1440 acres
MDC Boat Landing Area	2 acres
Private Lands	199 acres

Improvements - Total Estimated Value \$87,500

Land (Easement)

MDC & State Forest Lands	1440 acres	\$ 5,000
MDC Boat Landing Area	2 acres @ \$2000=	4,000

Land (Fee)

Private Lands - Total Acres 199 acres

Home Sites	8 $\frac{1}{2}$ acres @ \$1500=	12,750
Open Land	57 $\frac{1}{2}$ acres @ \$ 400=	23,000
Wooded, Waste & River	127 acres @ \$ 50=	6,350
Gravel Pit	3 acres @ \$1000=	3,000
Cemetery	3 acres **	-

Borrow Areas

MDC Land (Easement)	140 acres	*
Private Land (Fee)	10 acres @ \$ 300=	3,000

Land Total Estimated Value \$ 57,100

Severance 17,000

Cemetery Relocation - 3 acres @ \$2000 6,000

Contingencies 16,500

Acquisition Costs - 17 tracts @ \$1200 20,400

Resettlement Costs 2,500

TOTAL ESTIMATED VALUE \$207,000

* Value included in \$5000 item for MDC & State Forest Lands.

** Value included in relocations.

T. RELOCATIONS

45. Highways. - Route 8 extending in a north-south direction along the West Branch Farmington River in Massachusetts and Connecticut is the only highway affected by the project. The two State Highway Departments are giving consideration to possible relocation to the West, outside of the valley as well as to relocation along the valley above the reservoir as shown on Plates 1-1A and 1-1B. The Upstream Site will require relocation at a 7-foot higher elevation. This will have little effect in Connecticut but will require some extension of the relocation into Massachusetts if the valley location is selected. Relocation to the west, outside the valley, would not be affected by the selection of either site.

46. Utilities. - There are no utility lines crossing the reservoir which will require relocation. Local power and telephone distribution lines enter the reservoir along Route 8 in Sandisfield and removal will be required. The length of lines to be removed will be 1.2 miles for either the Report Site or the Upstream Site.

47. Cemeteries. - Dubois Cemetery, containing an estimated 70 graves is located beside Route 8 in Sandisfield. Relocation of these 70 graves will be required regardless of whether the Report Site or the Upstream Site is selected.

U. SCHEDULES FOR DESIGN AND CONSTRUCTION

48. Design. - Preparation of plans and specifications for the dam and appurtenant structures is scheduled for completion in June 1964.

49. Construction. - It was planned to award a continuing contract for construction of the dam in the Spring of 1965. For the Report Site, the award date should be advanced to the Summer or Fall of 1964 to permit rock and talus removal prior to construction of the conduit. For both sites the construction schedule would then be the same. The conduit would be constructed in the 1965 construction season. In the 1966 construction season the stream would be diverted in the spring and the lower part of the embankment constructed. In the 1967 construction season the embankment would be completed. All work would be completed in the Spring of 1968.

50. Stream Control. - Construction will require unwatering the Hogback Reservoir. During the construction period the discharge past the site will be controlled by the gate capacity at Hogback. At the Upstream Site, the possibility of inundation during construction will be lessened and the required height of cofferdams decreased.

V. COST ESTIMATES

51. Cost Estimates. - Comparable estimates of cost have been prepared for the Report Site and the Upstream Site. The estimated total cost for construction at the Upstream Site is \$11,300,000, which is the same as given in the interim report and submitted to Congress. The estimated total cost for construction at the Report Site is \$12,700,000. The difference is attributable to removal of rock and talus which exist on the Report Site.

Unit prices used are consistent with costs experienced with similar projects in the vicinity. The price used for borrow excavation reflects length of haul which will be about one half mile less for the Upstream Site. Contingencies in the estimate for the dam at the Report Site are taken as approximately 10 percent in view of the fact that the talus and rock removal items are taken at the maximum anticipated quantities. Approximately 15 percent is used for the Upstream Site. Costs of relocations are based on the interim report with pro rata adjustment for additional length of relocation at the higher level. Real estate costs are based on a recent appraisal of the area. The higher engineering costs for the Report Site reflect the additional explorations and studies needed to properly care for the talus and rock conditions. Detailed estimates are given in Table III starting on Page 25 with Summary on Page 27.

W. RECOMMENDATION

52. Recommendation. - It is recommended that the Upstream Site as described in this report be approved for development of project plans for the Colebrook River project.

TABLE III
DETAILED COST ESTIMATE
COLEBROOK RIVER DAM AND RESERVOIR

REPORT SITE						UPSTREAM				
Item	Quantity	Unit	Unit Price	Amount	Total	Quantity	Unit	Unit Price	Amount	Total
<u>Lands and Damages</u>										
Land in fee	176	Ac.	L.S.	44,500		209	Ac.	L.S.	54,100	
Easements	1,656	Ac.	L.S.	9,000		1,582	Ac.	L.S.	9,000	
Improvements	4	Ea.	L.S.	86,000		5	Ea.	L.S.	87,500	
Severance				13,000					17,000	
Contingencies				14,800					16,500	
Resettlement cost				2,500					2,500	
Acquisition cost				19,200					20,400	
Total Lands and Damages Cost					189,000					207,000
<u>Relocations</u>										
Route 8 in Connecticut	2.7	mile	L.S.	1,359,000		2.7	mile	L.S.	1,359,000	
Route 8 in Massachusetts	2.2	mile	L.S.	1,074,000		2.6	mile	L.S.	1,274,000	
Utilities Removal Cost	1	Job	L.S.	3,000	55,000	1	Job	L.S.	3,000	64,000
Cemetery Reloc	70	graves	L.S.	18,000		70	graves	L.S.	18,000	
Contingencies				353,000	301,000				382,000	325,000
Total Relocations Cost					2,807,000					3,036,000
<u>Reservoir</u>										
Clearing	250	Ac.	\$400	100,000		280	Ac.	\$400	112,000	
Contingencies				20,000					22,000	
Total Reservoir Cost					120,000					134,000
<u>Access Road</u>										
Road	1	Job	L.S.	156,000		1	Job	L.S.	117,000	
Bridge	1	Job	L.S.	70,000			NONE			
Contingencies				45,000					24,000	
Total Access Road					271,000					141,000

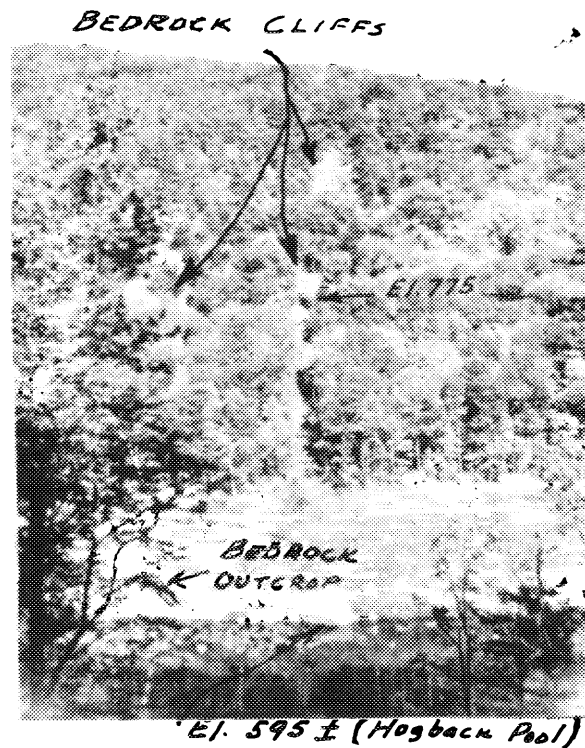
TABLE III (Cont'd)

REPORT SITE						UPSTREAM SITE					
Item	Quantity	Unit	Unit Price	Amount	Total	Quantity	Unit	Unit Price	Amount	Total	
<u>Dam</u>											
Preparation of Site	30	Ac.	\$600	\$ 18,000		30	Ac.	\$600	\$ 18,000		
Stream Control	1	Job	L.S.	100,000		1	Job	L.S.	100,000		
Excavation, General	64,100	CY	0.80	51,280		59,100	CY	0.80	47,280		
Stripping	51,100	CY	1.00	51,100		55,200	CY	1.00	55,200		
Impervious Fill	512,300	CY	0.20	102,460		528,700	CY	0.20	105,740		
Impervious Borrow	614,800	CY	0.55	338,140		634,400	CY	0.50	317,200		
Random Fill	1,530,900	CY	0.18	275,562		1,353,700	CY	0.18	243,666		
Random Borrow	1,837,100	CY	0.55	1,010,405		1,624,400	CY	0.50	812,200		
Select Gravel Fill	681,400	CY	0.20	136,280		729,600	CY	0.20	145,920		
Select Gravel Borrow	817,700	CY	0.60	490,620		875,500	CY	0.55	481,525		
Top of Dam	1	Job	L.S.	6,400		3,500	CY	2.00	7,000		
Rock Excavation	291,000	CY	2.50	727,500		337,300	CY	2.50	843,250		
Rock Fill	280,000	CY	0.25	70,000		334,800	CY	0.25	83,700		
Rock Slope Protection	83,800	CY	0.75	62,850		86,800	CY	0.75	65,100		
Dike	61,100	CY	1.20	73,320		81,100	CY	1.20	97,320		
Rock Removal	133,000	CY	3.50	465,500							
Talus Removal	406,200	CY	2.25	913,950							
Concrete, mass	11,600	CY	40.00	464,000		11,600	CY	40.00	464,000		
Concrete, reinf.	10,900	CY	70.00	763,000		10,900	CY	70.00	763,000		
Concrete, service bridge deck	130	CY	117.00	15,210		130	CY	117.00	15,210		
Service bridge (superstructure)	1	Job	L.S.	75,000		1	Job	L.S.	75,000		
Gates and machinery	1	Job	L.S.	260,000		1	Job	L.S.	260,000		
Misc. items				308,190					308,190		
Unwatering Hogback during construction	1	Job	L.S.	80,000		1	Job	L.S.	80,000		
Contingencies	10% +			<u>689,233</u>		15% +			<u>808,499</u>		
Total Dam Cost					\$7,548,000					\$6,197,000	
<u>Buildings, Grounds and Utilities</u>											
Utilities	1	Job	L.S.	71,600		1	Job	L.S.	71,600		
Contingencies				<u>14,400</u>					<u>14,400</u>		
Total Buildings, Grounds and Utilities Cost					86,000					86,000	
<u>Permanent Operating Equipment</u>											
Contingencies	1	Job	L.S.	16,000		1	Job	L.S.	16,000		
				<u>3,000</u>					<u>3,000</u>		
Total Permanent Operating Equipment Cost					19,000					19,000	

TABLE III (Cont'd)
DETAILED COST ESTIMATE
COLEBROOK RIVER DAM AND RESERVOIR

SUMMARY OF FEDERAL COST

	<u>REPORT SITE</u>	<u>UPSTREAM SITE</u>
LANDS AND DAMAGES	\$ 189,000	\$ 207,000
RELOCATIONS	2,807,000	3,036,000
RESERVOIR	120,000	134,000
ACCESS ROAD	271,000	141,000
DAM	7,548,000	6,197,000
BUILDINGS, GROUNDS AND UTILITIES	86,000	86,000
PERMANENT OPERATING EQUIPMENT	<u>19,000</u>	<u>19,000</u>
SUB-TOTAL	11,040,000	9,820,000
ENGINEERING AND DESIGN	880,000	800,000
SUPERVISION AND ADMINISTRATION	760,000	660,000
PREAUTHORIZATION STUDIES	<u>20,000</u>	<u>20,000</u>
TOTAL PROJECT FIRST COST	\$12,700,000	\$11,300,000



East abutment at survey base line



Looking up west abutment at survey base line

REPORT SITE

FIG. 1

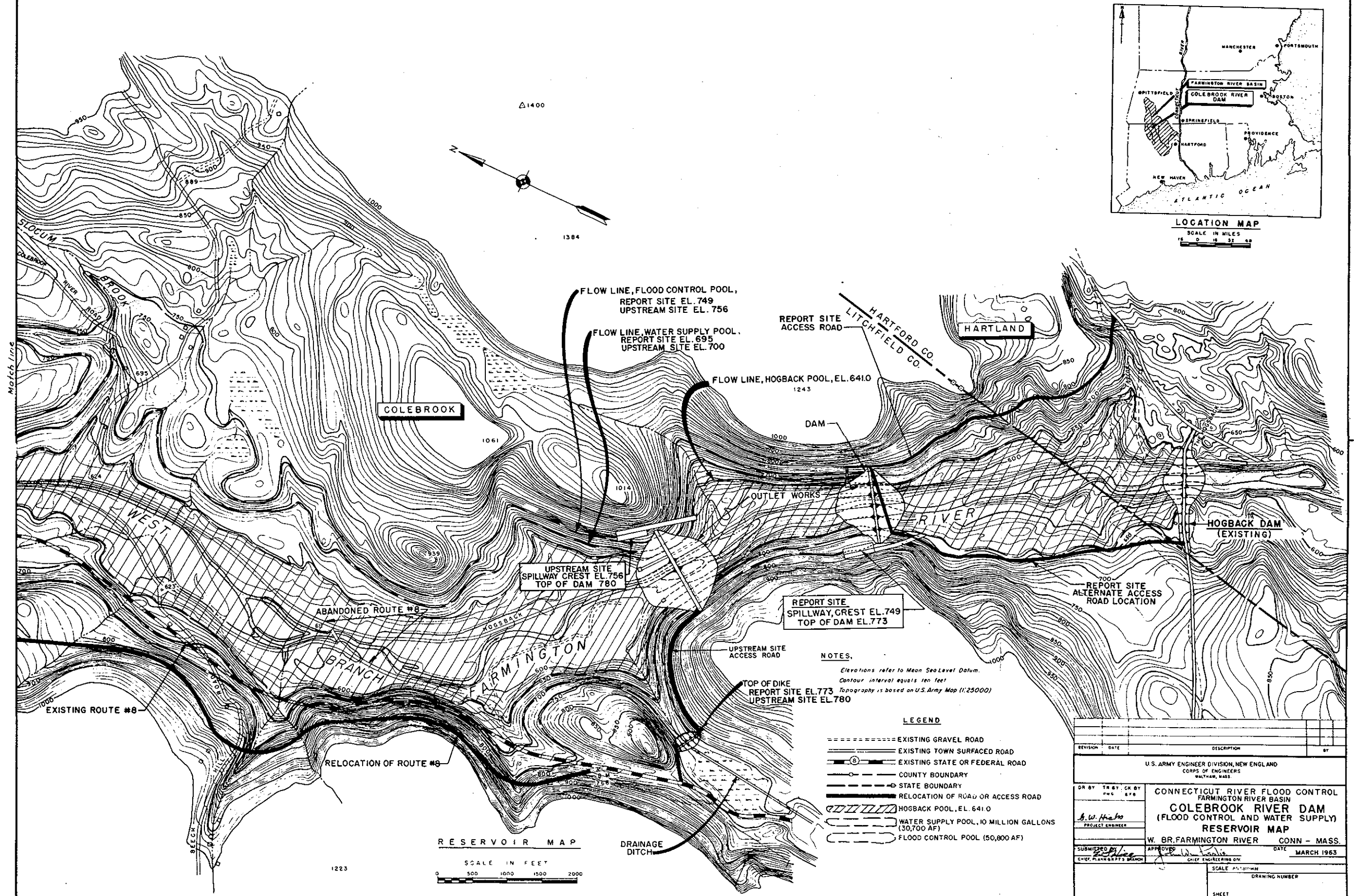


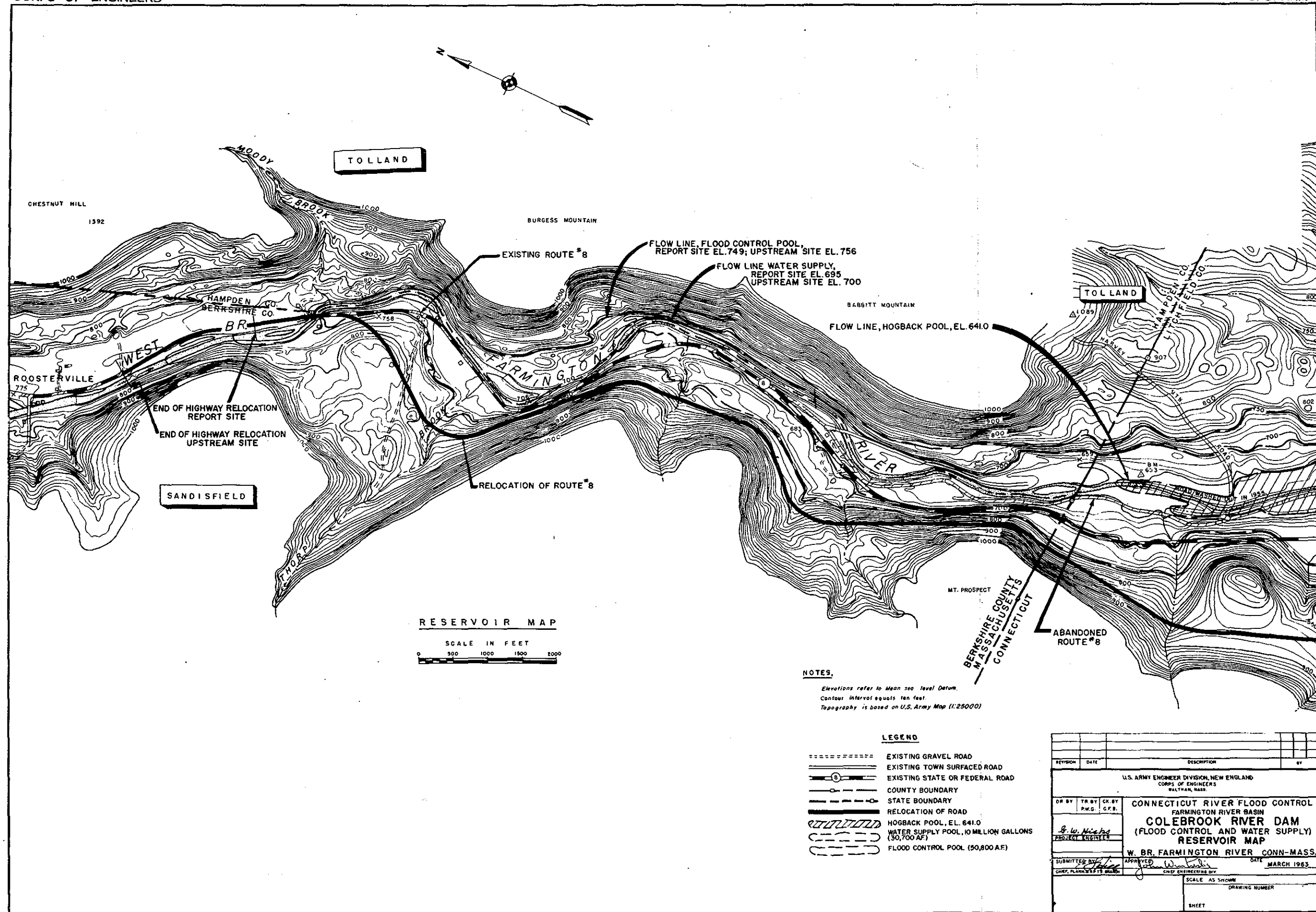
East abutment



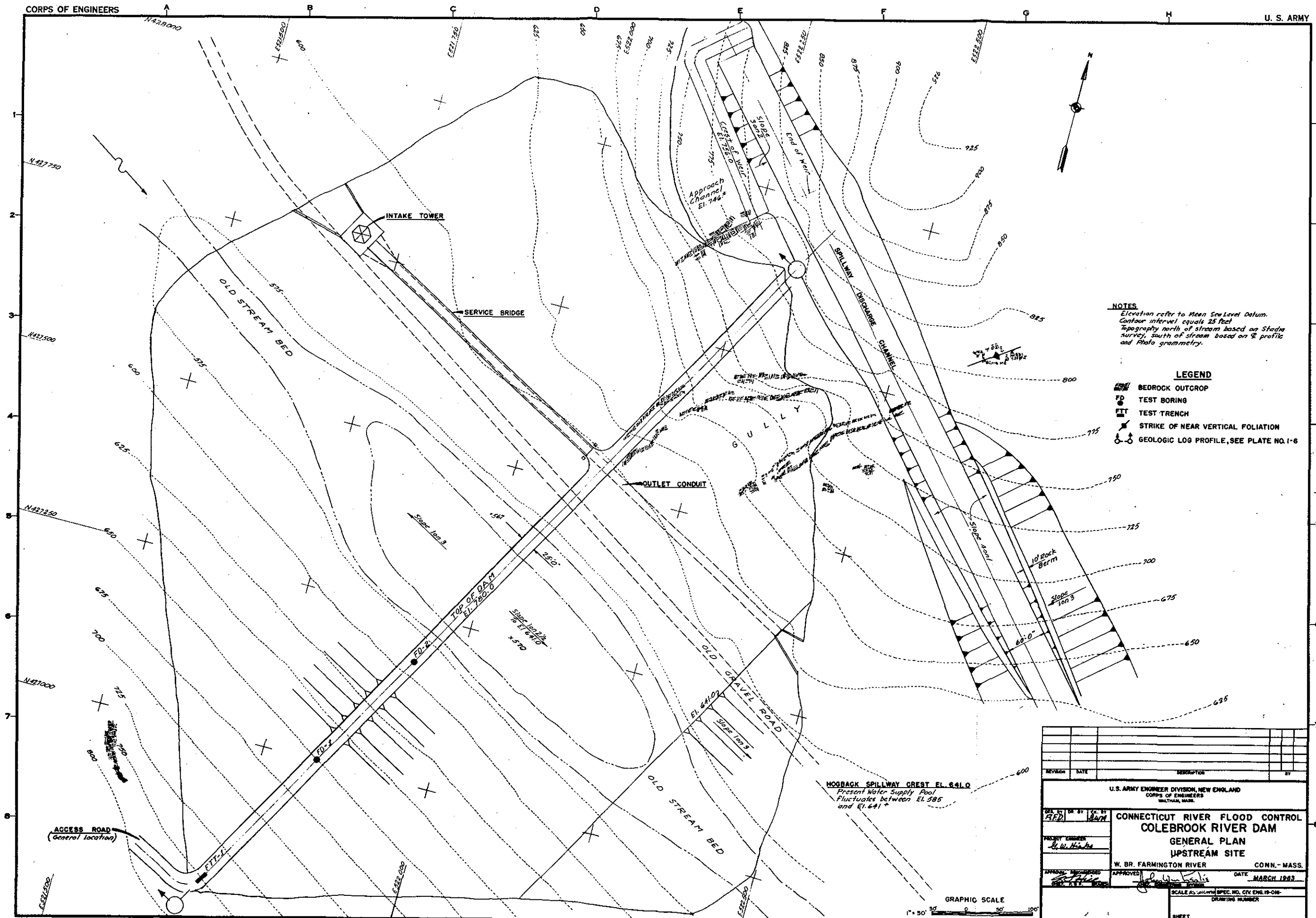
Looking up gully on east abutment

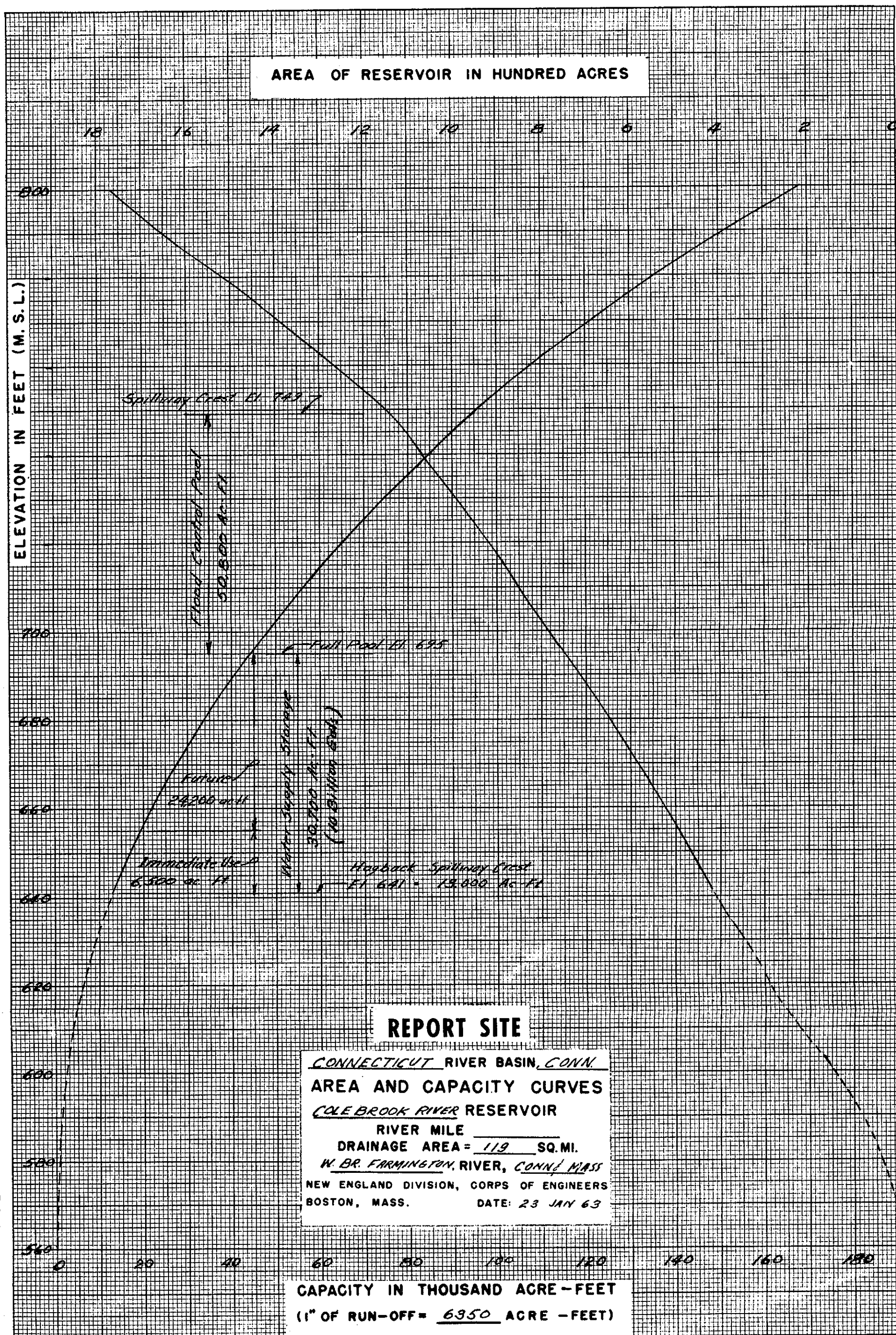
UPSTREAM SITE

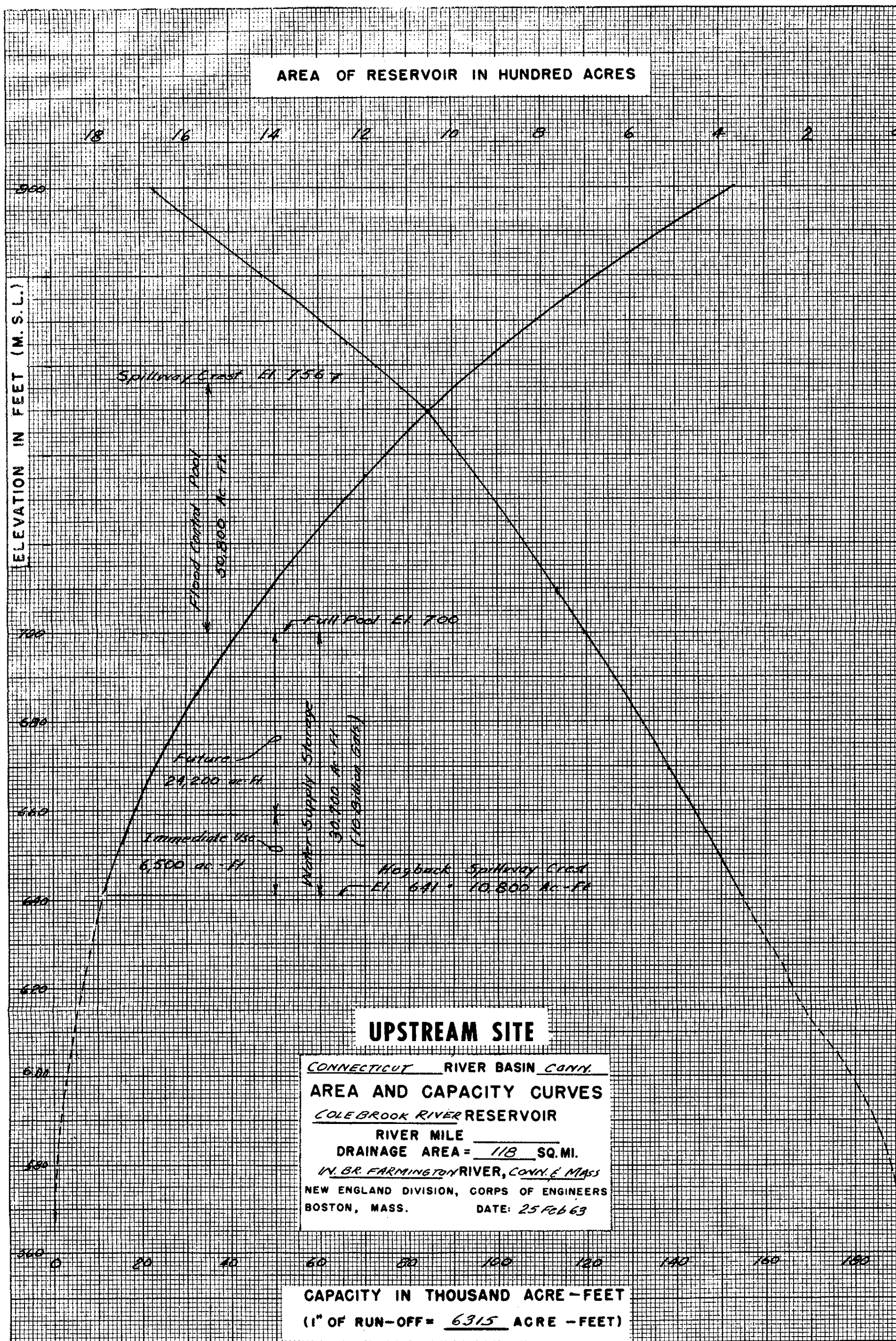


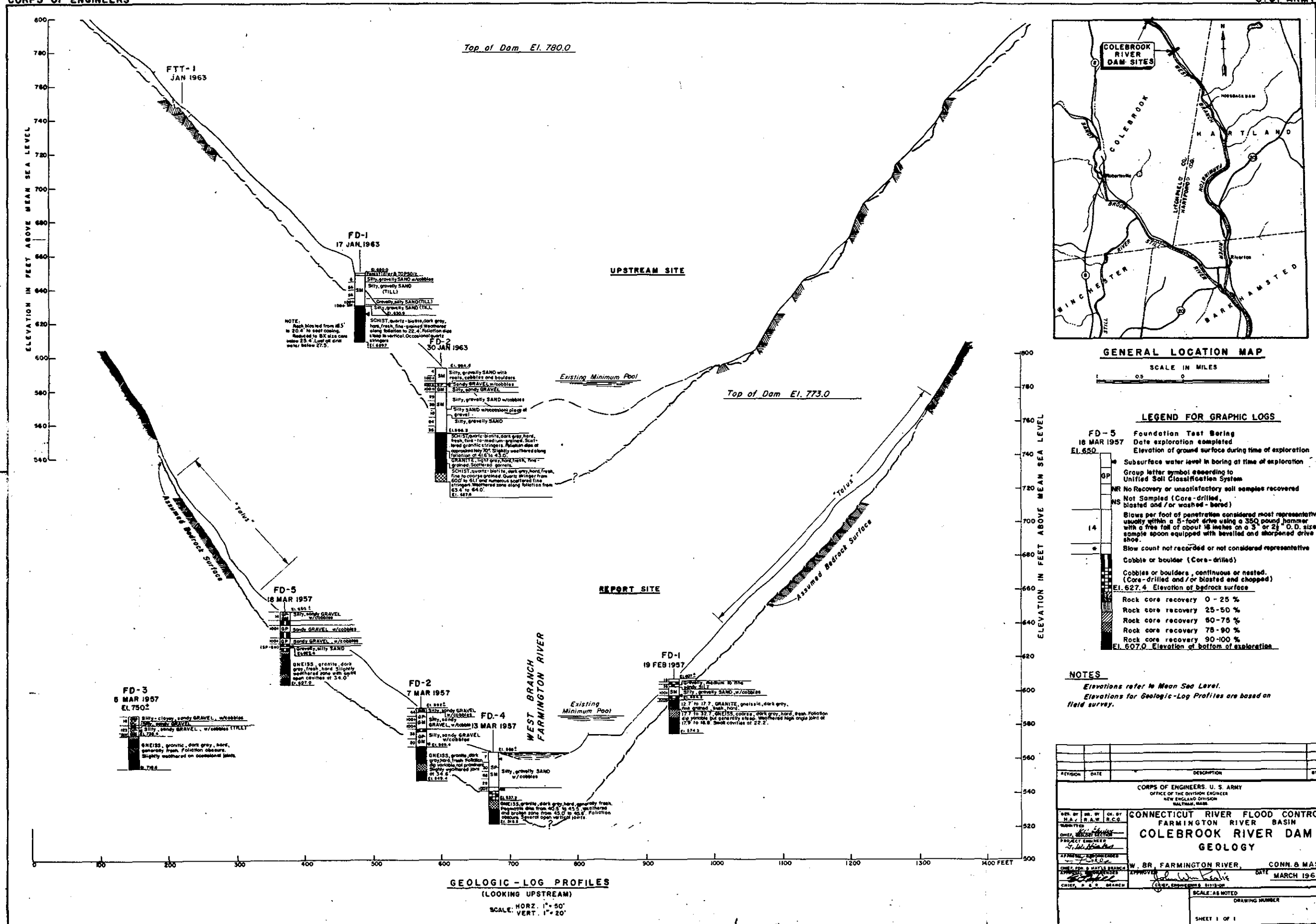


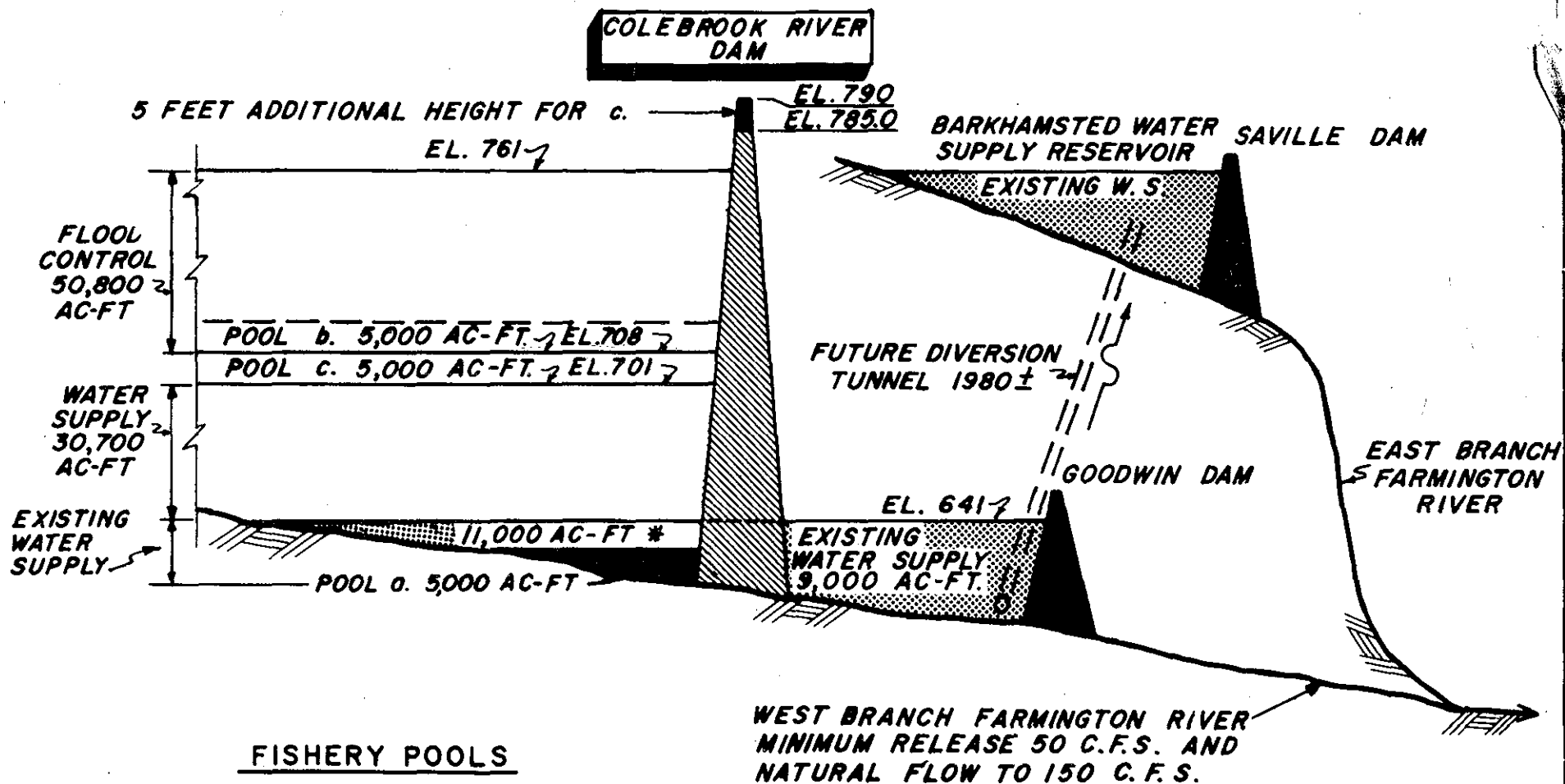












FISHERY POOLS

- POOL a. 5,000 AC-FT. HOLDOVER POOL, IN WATER SUPPLY ZONE
- POOL b. 5,000 AC-FT. FOR SHAD, IN FLOOD CONTROL ZONE
- POOL c. 5,000 AC-FT. FOR SEA-RUN BROWN TROUT, REQUIRES RAISING DAM
- * THE EXISTING WATER SUPPLY ZONE OF 11,000 AC-FT INCLUDES POOL a.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL
COLEBROOK RIVER DAM

FISHERY POOLS

DATE: OCT. 1964